Control of roundworms in cattle

This document is part of the COWS Technical Guide which aims to provide a sound basis for advice to the industry.

The manual also comprises chapters on controlling lungworm, liver and rumen fluke, ectoparasites and practical parasite control planning.

COWS
Control Of Worms Sustainably

COWS is an industry initiative promoting sustainable control strategies for parasites in cattle

With thanks to Professor Eric Morgan, Queen's University Belfast, Professor Diana Williams and Dr John Graham-Brown, University of Liverpool for help and guidance in writing this COWS chapter.

Section 1: Top tips for controlling roundworms (Parasitic Gastroenteritis or PGE) in cattle

Informed and sound preparation will minimise roundworm infection with positive effects on enterprise returns.

Identify risk

1. All grazing cattle are exposed to round/gut worms and consequently can suffer production losses. Younger cattle are most at risk of disease until they acquire immunity. The potential production loss increases with increasing parasite challenge
2. Permanent pastures that have been grazed by youngstock in the past 12 months present a high risk. The safest pastures are new sown leys, followed by hay and silage aftermaths. These are considered to be 'clean'.
3. The infective larval stages of roundworms accumulate on pasture over the grazing season, typically peaking from mid-summer (July) onwards, when the risk of disease is highest
4. Without appropriate action, young cattle grazing late into the season can remain at risk of Type 2 disease post-housing into winter and early spring

Treat appropriately

5. Anthelmintics should be used in a manner that avoids their excessive use, while not compromising animal health, welfare and productivity. Treat with 'as much as is necessary, but as little as possible'
6. Inform treatment decisions through the monitoring of parasite burdens and/or animal growth rates
7. Administering an effective anthelmintic treatment in high risk situations to first season grazing calves at housing, will minimise the occurrence of Type 2 disease in late winter/early spring

Avoid resistance

8. Always use anthelmintics correctly. Follow the manufacturer's instructions concerning dosage and administration, their storage, shelf life and disposal. Avoid under-dosing. Weigh animals to be treated and calibrate dosing equipment accordingly
9. Anthelmintic resistance has been detected in *Cooperia oncophora* and *Ostertagia ostertagi* intestinal worms in the UK. This must be treated as an early warning. It is essential that anthelmintics are used responsibly
10. There are many risk factors for anthelmintic resistance. The best ways of limiting selection pressure on worm populations is to avoid treating cattle unnecessarily and to ensure the correct drug and dose is used
11. Where a treatment failure is suspected, discuss further investigation with the vet, suitably qualified person (SQP) or Registered Animal Medicines Adviser (RAMA)

Section 2: Introduction to roundworms (nematodes), *Ostertagia ostertagi* and *Cooperia oncophora*

Introduction

Cattle can acquire infections with any of several species of parasitic roundworms (nematodes) of the gastrointestinal tract. These parasites can be present in any fields where cattle graze.

The most common and important species in northern Europe are the brown stomach worm *Ostertagia ostertagi*, which lives in the abomasum (true stomach), and *Cooperia oncophora*, which inhabits the small intestine.

Key concerns

- Roundworms found on all cattle pastures
- Disease mostly seen in calves and young cattle
- Can reduce growth rates by 30%

These worms are ubiquitous and can be found on all cattle farms where animals have access to grassland, even when only for short periods.

Whilst these parasites are common, clinical disease (loss of appetite, scouring and poor condition), is generally only seen in young calves during their first grazing season, when control has been inadequate.

Even in the absence of clinical disease, infected animals can experience a loss of production, which may be economically important, but can be difficult to detect without accurate observation and recording.

Growth rates in youngstock may be reduced by up to 30%, even with a low level of worm challenge. Infection in adult dairy cows can be associated with losses of up to 1kg of milk yield per day.

Disease

Ostertagiosis

Ostertagia ostertagi develop to adults from infective stage larvae in the gastric glands of the abomasum, causing damage to both glandular and surrounding tissues.

The diseased abomasum is thickened and the parasitised glands can easily be seen as raised nodules on the inside surface of the stomach, sometimes referred to as looking like 'Moroccan leather' in appearance.

This pathology has a number of knock-on effects, the most significant being the loss of protein into the gut. Also, reduced gastric secretions and therefore acidity, lead to disruption of protein digestion, a release of appetite suppressing compounds and overgrowth of gut bacteria. Collectively, these changes lead to scours, anorexia, malnutrition and poor growth or condition loss in affected animals, often despite being fed high quality forage.

This conventional form of ostertagiosis, known as Type 1 disease, is typically seen in young grazing cattle in mid-summer. Less commonly, disease can appear towards the end of the housing period in the subsequent winter and early spring, known as Type 2 ostertagiosis.

Parasitic Gastroenteritis

The pathology resulting solely from infections with *C. oncophora* in the small intestine is much less obvious than that induced by *O. ostertagi* in the abomasum. However, these roundworms still cause microscopic damage to the intestinal lining that can lead to poor digestion and absorption of nutrients.

Under normal field conditions, young cattle are almost always co-infected to some degree with both *Ostertagia* and *Cooperia* species at the same time, in addition to various others. There is some evidence of

Figure 1: *Ostertagia* lesions on abomasal mucosa.



Moredun Research Institute

Type 2 Ostertagiosis

This condition generally only affects a small proportion of animals in a group, but disease can be sudden and severe, with deaths known to occur.

The cause is the simultaneous development and emergence of a large population of inhibited or arrested (hyperbiotic) larvae. This happens where large numbers of the infective third stage larvae (L_3) are ingested at the end of the preceding grazing season.

Instead of developing over a three week period to adults, as normally happens earlier in the year, these larvae enter the gastric glands and then stop developing, lying dormant as immature fourth stage larvae (L_4).

These L_4 persist in the stomach wall for several months over winter until a presently unknown trigger, stimulates them to resume development. Where large burdens are present, this mass resumption of development and subsequent emergence from the abomasal wall, causes sudden, extensive damage leading to severe clinical disease, characterised by sudden onset, profuse and watery scours.

Signs of *O. ostertagi* infection

- Loss of appetite
- Loss of body weight and condition
- Diarrhoea

synergy between these species.

The damaged small intestine resulting from *Cooperia* infection cannot compensate for the poor protein digestion and protein loss from the abomasum caused by *Ostertagia*. The combined impact of both infections is therefore additive and is collectively characterised as parasitic gastroenteritis (PGE).

In heavy infections, these changes in the gut can lead to the most obvious clinical sign, which is diarrhoea. Loss of nutrients and fluids is partially responsible for the loss of weight and body condition in affected animals. However, the greatest cause of ill-thrift is reduced feed intake, which can account for 60–70% of weight loss observed in young parasitised cattle.

Though not so marked, a loss of appetite also seems to explain much of the production loss observed in adult cattle infected with *O. ostertagi.*

Section 3: The parasites

Biology

Ostertagia ostertagi and *Cooperia oncophora* are members of a diverse class of worms called nematodes, commonly known as roundworms.

Parasitic nematodes are generally host-specific, so cattle nematodes rarely successfully infect sheep or other livestock. However, there are a few exceptions, such as *Nematodirus battus* and *Haemonchus contortus*, sheep nematodes which occasionally cause disease in calves.

This general host specificity underpins the use of alternative or mixed grazing strategies to reduce the risk of heavy parasite burdens in livestock. Sheep can generally graze pastures contaminated with cattle roundworms and vice versa.

It should be noted however, that co-grazing may be inappropriate if parasites such as *Fasciola hepatica* (liver fluke) are present, as these readily infect both sheep and cattle (see COWS liver fluke chapter). Similarly, some Herd Health Schemes recommend avoiding co-grazing with sheep to control transmission of Johnes Disease.

Life cycle

Adult parasitic roundworms of cattle are a few millimetres long and just visible to the naked eye, if the abomasum or intestines of infected animals are examined post-mortem. Microscopy is needed to appreciate finer structures and to see immature larvae.

The life cycle of cattle parasitic nematodes is direct. No intermediate hosts are involved and transmission among animals is via infective larvae from pasture.

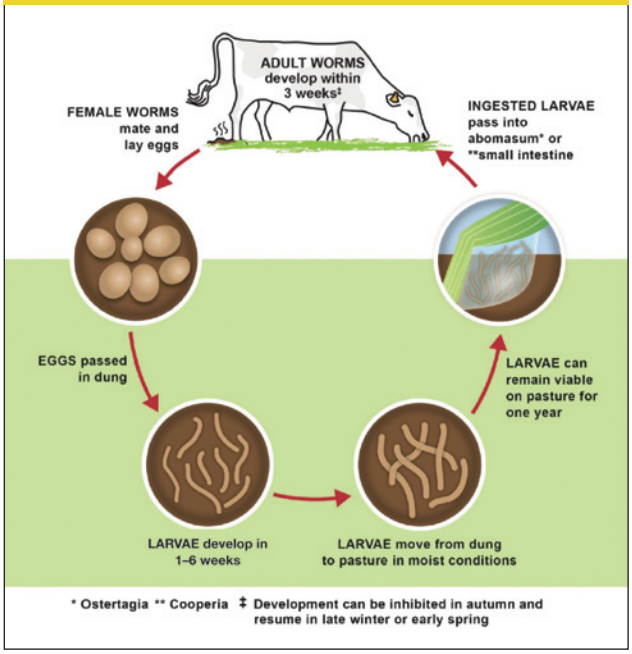
These worms do not have a migratory phase within the host. There are two sexes and mating is required between males and females for the latter to produce fertile eggs.

Figure 2: Adult female *Cooperia oncophora*.



Moredun Research Institute

Figure 3: Roundworm life cycle



Eggs are passed out in the faeces. Given the right temperature and moisture conditions, the first

stage larvae hatch out in dung. These larvae develop through two further stages, ultimately becoming the infective third stage larvae (L_3).

The rate of development is largely temperature-dependent providing adequate moisture is available in the pat. It can be completed within a week or less when the environmental temperatures are 15 to 23°C, and within three to six weeks at temperatures of around 10°C.

Rainfall is also important to enable infective larvae to leave the pat and make their way onto herbage, where they are more likely to be ingested by cattle.

Larvae have limited mobility but can migrate a few centimetres from faeces if conditions are moist. More important is the effect of rainfall, which softens the pat and raindrop splashes help disperse larvae over greater distances.

Infective L_3 are protected by an outer sheath, which is the retained 'skin' of second stage larvae. This makes them relatively resilient and they can survive on pasture for many months – some for over a year under normal environmental conditions in the UK.

The L_3 are sensitive to desiccation, so larval survival is reduced during hot, dry spells of weather. However, a proportion of the larval population will shelter in soil and emerge again after rain. They survive particularly well in cool, damp conditions.

Grazing management for worm control is based on knowledge of when, and how long it takes for infective larvae to appear on pasture and how long they survive. This information underpins strategies intended to limit exposure of grazing cattle to challenge.

When cattle ingest infective L_3, they pass to their preferential sites for development, the abomasum for *O. ostertagi* and the proximal small intestine for *Cooperia* spp.

During spring and summer when L_3 larvae are eaten, they establish in the gut of the cattle and develop into adult worms within about three weeks, at which time females start to produce eggs.

The interval between ingestion of larvae and appearance of worm eggs in dung is known as the pre-patent period. This is an important measurement, as it helps plan worm control programmes, particularly where the objective is to limit contamination of pasture with worm eggs.

Both *O. ostertagi* and *C. oncophora* can slow their development in the gut of cattle under some circumstances. Inhibition of larval *O. ostertagi* is an adaptation for survival and carriage over winter and into the next grazing season. If the numbers of developing larvae are small, there may be few consequences for the host animal. However, where burdens are heavy, this process can result in Type 2 disease.

Section 4: Immunity

Cattle acquire immunity when exposed to roundworms. However, it takes a relatively long time – roughly one full grazing season for *C. oncophora* and up to two grazing seasons for *O. ostertagi*. Even then, immunity is not complete. Cattle of all ages still have worms, particularly *O. ostertagi*, which can continue to impact host health and productivity.

Older cattle tend to have significantly lighter burdens of adult worms than young cattle, lower faecal worm egg counts (fWECs), and rarely show signs of disease, but may still incur sub-clinical production losses.

The rate immunity develops is a function of exposure to infective L_3. Functional immunity can develop even when anthelmintic treatments are given during their first grazing season. However, if young cattle have no exposure at all to pasture as calves, for example calves born in summer in year-round-calving dairy herds, then they should be considered parasite-naïve when they go out to grass the following year.

Acquiring immunity

- Can take up to two grazing seasons
- Immunity is never absolute
- Only develops where cattle graze contaminated pasture

Calves that are over-protected in their first season at grass by excessive anthelmintic treatment are also at risk of slow development of immunity.

Poor development of immunity in replacement heifers can lead to greater susceptibility in milking

cows and the risk of production losses if they become exposed.

From the perspective of immunity and longer-term resilience, there is a balance to be struck whereby youngstock is exposed sufficiently to develop immunity, but without putting them at risk of clinical disease.

Cattle must be on pasture used by cattle for at least eight months of the previous year, to obtain sufficient exposure for immunity to develop. This can help farmers to identify the time and age at which reasonable levels of immunity will be acquired. In most management and grazing systems, the total time of effective contact (TEC), is likely to be split over the first two grazing seasons.

In reality, levels of exposure will be affected by other factors, including the effect of climate on development and survival of infective larvae.

Immune development is also influenced by host factors including age, sex, nutrition and potentially, genetics.

Section 5: Epidemiology

Most cattle in northern Europe are housed over winter and there is virtually no acquisition of new worm infections, as animals are not grazing and negligible numbers of L_3 will survive in hay or silage. It is, however, important to consider the grazing history of fresh grass being harvested and fed to zero-grazed cattle.

Over winter there is limited and slow development of eggs and larvae in dung pats deposited before housing. In this period there is also a gradual decline in the number of L_3 on pasture, as these stages do not feed and slowly use up their energy reserves. However, sufficient numbers will usually survive to infect calves lightly early in the following spring.

Once cattle are turned out, they can acquire infections from these residual over-wintered L_3 populations, as well as those developing from eggs shed by older sub-clinically infected cattle.

When weaned calves in their first grazing season with limited or no immunity ingest these L_3, a high proportion of worms establish and develop to adults, which produce eggs.

Changes in weather, such as dry summers or mild autumns, can affect the level of larval challenge and consequently the risk of disease in cattle, as well as the development of immunity.

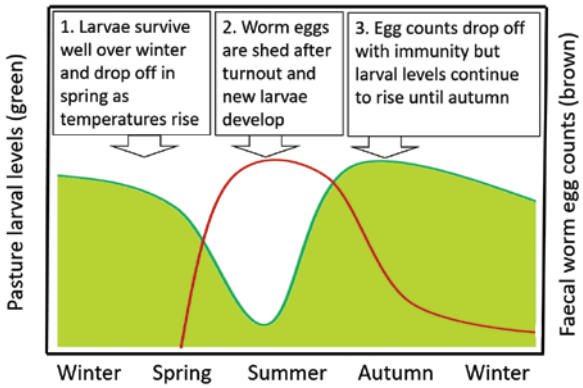
While dry summers are likely to slow down the accumulation of larvae on pastures in general, the situation can change rapidly following rainfall, when large numbers of L_3 in cow pats are released onto pasture all at once.

Computer models have been developed to predict the effect of weather, grazing patterns and treatment on pasture larval levels and these can be used to support sound decisions under climate change. Meaningful risk forecasts cannot be made without information on grazing history.

Risk factors

- Cattle in the first grazing season have no immunity
- Adult worms shed eggs, leading to build-up of larvae on pastures
- Peak larvae numbers reached in late summer
- Exposure can be reduced using grazing strategies

Figure 4: Pasture larval levels and faecal worm egg counts for roundworms throughout the seasons



Section 6: Control

The aims of control programmes for gastro-intestinal nematodes are to:

1. Prevent clinical disease
2. Prevent sub-clinical production losses
3. Allow the development of immunity

Anthelmintics are an important part of any control programme. However, many of the gastro-intestinal nematode species have developed resistance to anthelmintics, so these medicines must be used carefully.

The aim should be to avoid excessive use and over-reliance on worming products to reduce selection pressure for drug resistance, as well as limiting any unwanted environmental impacts many anthelmintics can have.

Every farm is different and control measures that work on one farm may not necessarily be appropriate on another. Size of farm, stock number and type, management, land type, etc., will affect which control options are most cost-effective, while minimising the potential risk of resistance.

In young cattle, probably the most important measure of performance is growth rate, whether animals are destined to be fattened for beef or replacement heifers.

Average growth rates of 0.7kg per day or more, on pasture are required if beef cattle are to be finished before they are two years old and replacement heifers are to calve at 24 months.

Although adult cattle are rarely the focus of routine worm control, they can be important epidemiologically and can experience production losses. They should not be ignored.

Grazing strategies

It may be possible to identify and use pastures in a strategic way during the grazing season that will reduce exposure to youngstock and reduce disease risk significantly.

Early in the season, pastures that have not had cattle grazing in them the previous year, such as new sown leys, would be considered 'clean'. Fields not grazed early in the season, such as those shut up for hay or silage, will also have low to no worm burdens and are also safe to be grazed later in the season, as they become available.

Similarly, the number of overwintered L_3 on pastures declines in spring as higher temperatures increase their activity, meaning their energy reserves deplete more quickly. Such populations have largely disappeared by early June.

If sheep are present on the farm, they can participate in mixed or sequential grazing, which can potentially benefit both types of stock through worm control and improved pasture utilisation. However, care must be taken when there are liver fluke on the farm, due to the risk of cross-infection between cattle and sheep.

When pursuing clean grazing strategies, it is important to remember the need to provide some exposure to promote immunity, meaning some degree of exposure to roundworms at pasture is required and encouraged at some point.

Control options

- Grazing strategies
- Targeted anthelmintic treatments based on diagnostic information
- Strategic anthelmintic use to minimise pasture contamination
- Therapeutic anthelmintic use based on monitoring stock health and growth rates
- Housing treatments

Figure 5: Aim to minimise pasture contamination.



Moredun Research Institute

Anthelmintics

Anthelmintics can be used:

a. In targeted treatments – when dosing is administered as needed based on the results of routine faecal worm egg counts (fWECs) or weight changes/loss

b. Strategically –- where target groups of animals are treated, with the primary objective to limit the contamination of pastures with worm eggs
c. Therapeutically – to treat individuals or groups which are already suffering losses. The aim of any control programme is to avoid this situation occurring.

It is extremely important to consider the risk of lungworm infection when making any changes to control measures aimed at gastro-intestinal worms.

Targeted treatments are based on routine monitoring of at risk cattle over the grazing season and targeting treatments to those animals and groups where they are needed most.

Diagnostic and performance indicators can be used to monitor cattle health and parasite burdens to identify those that need treating and when this is required.

Many additional factors can affect the results of this type of approach. The most important factors relate to reducing overall risk of exposure by taking advantage of the availability of safe and clean pastures. Also, by assessing the degree of risk present in fields grazed early in the season resulting from overwintered larvae, and then from mid-summer when L_3 numbers and disease risk traditionally peaks. More details of the monitoring options are given in Section 7.

This method requires careful planning and focus throughout the season, taking timely fWECs and acting when needed.

This approach also allows animals to gain exposure to lungworm infection where it is present. This can be useful for building immunity to lungworm. However, routine monitoring of PGE does not provide any meaningful information on lungworm status. See more in the Lungworm and Parasite Control Planning chapters of this guide.

Strategic treatments are highly effective in controlling PGE exposure and risk in youngstock where grazing is limited. Assuming that these pastures have overwintered L_3 burdens, at risk animals are set-stocked and dosed early in the grazing season, usually within three weeks of turnout.

This timing is intended to mitigate the pre-patent period – the time between when an animal is infected and when the worms start producing eggs – killing worms before they reach maturity. This prevents the shedding of eggs and recontamination of the pasture by these same animals during the current grazing season.

Since overwintered L_3 will largely die off by early June and set stocked animals have been treated strategically ahead of patent infection, L_3 burdens and pasture risks should be negligible by mid-season, meaning further treatment should not be needed until the calves are housed in the autumn.

Examples of this approach are to either administer a long-acting macrocyclic lactone (ML) product once at, or shortly after turnout, or to use a shorter-acting product two to three times up until June, at an interval that is three weeks plus whatever residual activity the chosen product has (if any), against PGE-causing roundworms.

Where this is carried out correctly, this 'up front' emphasis on using wormers early in the season should effectively control disease and lead to fewer treatments being needed later on. This will allow animals to build natural immunity in the latter part of the grazing season in response to there being only low levels of infections.

It is, however, important to remember that this approach is based on the premise that animals will remain set stocked and therefore, control of pasture contamination is assured.

If these animals are moved onto fields grazed by other cattle earlier in the season, as the protection given by the strategic dosing comes to an end, they will be potentially fully exposed to a high parasite challenge that they are ill-equipped to deal with.

Conversely, moving these animals to clean grazing, such as silage aftermaths, later in the year is safe and may be of benefit.

In all cases, if animals are moved, the risk posed by the next pasture must be assessed and appropriate steps taken to maintain control.

Historically, strategic dosing has routinely been applied to autumn/winter-born weaned calves in their first grazing season and sometimes to spring-born calves in their second grazing season.

Whilst effective in preventing disease and facilitating immunity, this approach also imposes a high selection pressure for resistance to worming products, compared with targeted treatments.

It is particularly important to avoid treating calves and then moving them to fresh pasture such as hay or silage aftermath. It is now well known that such protocols strongly select for resistance.

Therapeutic treatments. Regardless of the control methods that are adopted and implemented, the risk of clinical PGE remains.

Affected animals should be treated appropriately with anthelmintics and other supportive therapies as required.

In the event of a breakdown in a PGE control programme, further investigation is needed to identify and limit potential ongoing risk to other animals. This should be done with the vet or animal healthcare advisor. It is important to put measures in place to prevent such risks re-occurring in the future.

Housing treatments

Treatment of cattle for parasites at housing using anthelmintics should be considered.

Such treatments are therapeutic, removing residual worm burdens and their ongoing effects for the remainder of the housing period. They can also be considered as being strategic, in that they can reduce the degree of pasture contamination in the early part of the following grazing season.

Products containing MLs will also kill the encysted *O. ostertagi* larvae responsible for causing Type 2 ostertagiosis. Benzimidazoles may also be used for this purpose if they are known to be effective against inhibited larvae.

Diagnostic information should be considered as part of this process. For *Ostertagia ostertagi*, plasma pepsinogen testing at, or soon after housing, indicates level of exposure during the first grazing season. This can help inform whether animals are at risk from, and therefore require, prophylactic treatment for Type 2 disease.

Use the product most suitable for the time of year and management of the cattle involved.

See the Parasite Control Guide from AHDB for all the products available in the UK.

It may also be possible to use more than one parasiticide and/or combination product at housing, as it is also a good time to treat for lungworm and liver fluke. Use the product most suitable for the time of year and management of the cattle involved.

Quarantine

Incoming or returning stock should be tested and treated to minimise the risk of introducing resistant roundworms to the farm. This can be achieved through treatment efficacy testing (See Section 7), with additional treatment with a different class of product if resistance is discovered.

Where possible, bought-in cattle should be put onto pasture with a low/moderate level of contamination, so that they become infected with the local parasite population. This will dilute any resistant worms they may be carrying.

Section 7: Monitoring and Diagnostics

Given the changing and less predictable climate, traditional calendar-based treatment control programmes may no longer be fit for purpose. Such practices also exert significant selection pressures for resistance.

COWS strongly advocates an approach which assesses worm challenge in a group of animals, maximising animal performance while minimising anthelmintic use.

Anthelmintics remain a vital part of parasite control programmes but they should only be used when there is clear indication that they are required.

Diagnostics and performance monitoring can help with decision-making particularly under variable weather conditions.

Parasite monitoring

- Regular weighing of young cattle
- Faecal worm egg counts (fWEC)
- Plasma pepsinogen
- Milk tests may be useful in dairy herds

Performance monitoring and targeted treatment

In the presence of adequate nutrition and absence of other endemic diseases, parasitic gastroenteritis is the main factor determining animal growth rates at grass.

Parasites are not evenly distributed among animals within a herd. The identification and treatment of those groups and individuals that are performing

Table 1: The benefits and limitations of faecal worm egg counts

Benefits	Limitations
Provide an indication of the future levels of pasture contamination due to numbers of eggs being passed out in faeces currently	Cannot provide an accurate indication of roundworm burdens
Indicate presence of active infections with egg-producing adult female nematodes	Do not directly relate to performance eg., liveweight gain or disease in youngstock
Indicate which animals are contributing most to pasture contamination, providing a selection criterion for targeted treatments to limit pasture contamination	Cannot determine nematode species in a dung sample, unless eggs are cultured
Indicate how effective an anthelmintic has been when used in post-treatment efficacy testing	Cannot detect all stages of infection, most notably the stages causing Type 2 ostertagiosis
Dairy cows with a positive fWEC at calving may have a reduced milk yield in the subsequent lactation	Do not reflect the degree of abomasal damage, especially in older calves and adult cattle
Can be included in the differential diagnosis of ill-thrift and scour in pastured cattle	Standard fWEC methods using salt flotation are not informative of lungworm or liver fluke status

poorly and/or have recorded high fWECs, can lead to a marked reduction in total worm infections, without widespread use and reliance on anthelmintics.

Monitoring infection in first and second season grazing calves can be done using fWECs and/or regular weighing of youngstock to determine growth rates.

An analysis of multiple studies using fWECs to monitor roundworm burdens and PGE risk in growing cattle, established that groups of animals with average individual egg counts measuring >200 eggs per gram (epg) of faeces after two months at pasture, have a significantly higher disease risk, compared with those with average counts below this threshold. Mid-season fWECs can therefore be informative if interpreted on this basis with treatment of those failing to reach growth targets or that have significant egg counts (>200 epg). This can result in good worm control, whilst reducing the number of anthelmintic treatments.

Routine monthly sampling can also provide further information relating to the timing and rate at which roundworm burdens are being acquired. Large increases in epg from one month to the next, would suggest significant rates of infection. Stable, consistently low fWEC results, would suggest the animals are encountering relatively low levels of exposure.

Routine monitoring by fWEC, also has the benefit of being able to assess the degree of contamination present on a given pasture, allowing informed decisions to be made in relation to future pasture management.

This approach can also help slow the development of resistance and promote good herd-level immunity to PGE, by increasing the *in refugia* population. This consists of parasites in the animals and on the pasture that have not been exposed to wormers, which also provides an appropriate challenge to stimulate immunity.

Monitoring growth rates

Monitoring growth rates can be used to focus treatment specifically on those animals which fail to reach a target average daily liveweight gain. However, this is only possible if an adequate plane of nutrition is provided, accurate weighing equipment is available, and an appropriate weight gain target is set. A figure of 0.75kg/day has been used in some farm trials. Others suggest using a target set for each particular farm/group of animals. For example, using the group's own mean average daily weight gain to identify those underperforming relative to their peers.

Faecal worm egg counts

Taking dung samples and measuring the concentration of worm eggs (faecal worm egg counts/ fWECs) can provide useful information about infection dynamics over a grazing season.

To be effective, this must be performed on freshly produced faecal samples. Refrigerated storage for short periods, up to a week, will not significantly impact the results.

Faecal worm egg counts are a good choice for monitoring infection in young calves and are a good predictor of pasture contamination.

The threshold of 200 eggs per gram (epg) for individual worm egg counts at two months after turnout, may be used to indicate whether calves are grazing contaminated pasture and require treatment and/or moving to cleaner grazing.

Composite fWECs can be used as a cost-effective initial screening for group-level infection. However, due to concerns over the sensitivity of fWECs obtained through this method, results require careful interpretation alongside other performance targets, such as weight loss and/or individual animal testing.

As a simple, cheap and convenient monitoring tool, submitting samples for pooled analysis from groups of first and second season grazers, every three weeks during their time at grass, can indicate whether cattle are on contaminated pastures. This will alert the farmer to the fact that these cattle have been exposed to infection.

Whilst useful, it is important to remember the limitations of using fWECs with cattle. They are a poor indicator of worm burden or the degree of impact infections are having on the host animal.

In adult cattle, fWECs are generally uninformative. This is due to the large volumes of dung produced and the dilution effect this has, meaning the epg is invariably low.

Faecal worm egg counts will also be low in animals that are immune and only indicate the presence of adult egg laying female worms, rather than indicating a health or disease concern.

Plasma pepsinogen

The concentration of pepsinogen in blood plasma is related to the extent of abomasal damage caused by *O. ostertagi*.

Pepsinogen levels measured soon after housing, can indicate high levels of exposure and production losses within the season. This means that animals are likely to be harbouring significant burdens of encysted L_4 and so be at risk of Type 2 disease later in the winter.

A pepsinogen threshold of >2.5 U Tyr has been used previously to inform treatment decisions. This was because the level was associated with sub-clinical infections and reduced weight gain that was reversed on treatment.

Worm antibodies

Antibodies are another measure of exposure and host immune response. Raised antibody levels do not always mean animals have developed fully protective immunity.

The concentration of *O. ostertagi* antibodies in milk is related to exposure and can provide a good estimate of potential loss of milk caused by the parasite at herd and individual levels. High antibody levels can prompt treatment in dairy cows but should also trigger review of herd control strategies.

Section 8: Anthelmintic resistance

Anthelmintic resistance (AR) is a global problem that is common and widespread in sheep and goat roundworms. It is increasingly being observed in cattle parasites.

In Europe, the parasite species currently implicated most in AR is *C. oncophora*, but it is increasingly reported in *O.ostertagia*, as well as the bovine lungworm *Dictyocaulus viviparus* and liver fluke. The impact of this issue is still unclear, but appropriate measures and stewardship are necessary now, to maintain the efficacy of current anthelmintics in the long term.

The challenges in achieving this include limiting selection for, and therefore delaying the emergence of AR and how to manage it when it does appear. In both situations, this has to be achieved without compromising animal health, welfare and productivity.

Risk factors for AR on European cattle farms are

Basic guidelines for performing an anthelmintic efficacy check

1. Before doing a check, perform a pooled fWEC by sampling 10–15 individual animals from the group to be tested. Ideally these should be calves in their first grazing season. If egg counts are reasonably high (>200 epg), proceed with treatment and efficacy check. Where egg count methods with higher sensitivity are used (1–10 epg), a lower threshold of 50 epg may be used
2. Collect faecal samples for individual testing on the day of treatment (Day 0). Collect at least 10g of each sample from three different areas of each pat into an individually identified plastic bags. Exclude air and keep cool
3. Administer anthelmintic in accordance to the manufacturer's instructions at a dose rate calculated from accurate body weight (using scales or a weigh band). Ensure all the dose is administered correctly
4. Collect faecal samples in the same manner as in Step 2, 14–17 days post treatment for benzimidazole and ML products, or at 7–10 days following treatment with levamisole
5. In all cases, process faecal samples at the lab as soon as is feasible. Samples should be re-mixed before any sub-sampling to help account for variation within a single pat. A detection limit of 5 epg or less is considered best practice to reduce the chance of mis-classifying resistance
6. Calculate percentage efficacy using the formula:
   %FECR = ((Mean Day 0 fWEC – Mean Day 14 fWEC) / Mean Day 0 fWEC) fWEC x 100
   The percentage efficacy should be at least 95%
7. Pooled fWEC can be used before and after routine treatment, even from fresh dung pats sampled at pasture to confirm good anthelmintic efficacy. This method is much cheaper and easier but not as accurate. Suspect efficacy from pooled counts should be followed up with a full check using individual samples whenever feasible. Individual tests allow a level of confidence in the calculated result

not fully understood, although studies have linked reduced efficacy to farm type, treatment practice and the movement of cattle between holdings. An obvious risk for selection pressure is the use of whole herd, frequent or continuous dosing regimes. Under-dosing may also allow (partially) resistant worms to survive treatment.

There are a number of common-sense practices that can help limit selection pressure on cattle worm populations (see Section 1: Top Tips for controlling parasitic gastroenteritis in cattle), without compromising worm control.

In addition, some of the newer approaches to parasite control, such as the Targeted Treatment approach in Section 7, can help farmers continue with successful production into the future.

Good quarantine and biosecurity measures (Section 6), are also essential to prevent accidentally introducing new strains of anthelmintic resistant roundworms – and other parasites, to the herd.

Section 9: Planning control on farm

Practical control advice should be tailored to the individual farm and consider:

- Production objectives for the different classes of cattle
- Farm infrastructure, particularly in relation to pastures, grazing management and handling facilities
- Presence of other helminth parasites, such as lungworm and liver fluke
- Efficacy of available anthelmintics.

Equipped with this information, it is possible to compile both a risk assessment and prospective control plan for PGE in all categories of stock, ahead of spring turnout.

Housing and turnout are good times to reflect on the parasite situation in the previous months and to plan for the future.

Once the risks have been quantified, it is possible to decide on control options, using management, diagnostics and testing, monitoring and anthelmintics if required.

The purpose of a parasite control plan is not to provide a rigid set of interventions which must be adhered to throughout the season, but a considered set of farm-specific issues that may, or may not be encountered, and farm specific actions that will deal with them effectively.

These documents should be a starting point for a dynamic on-going process, with continual review and actions informed by the circumstances present, such as the presence of disease, health observations, weather patterns, availability of grazing etc.

Where treatment is indicated, the actual choice of anthelmintic is ideally determined through discussions with the vet, animal healthcare adviser or SQP/RAMA at retail outlets.

For more information also see the COWS Practical Parasite Control Planning chapter.